Patient selection for extracorporeal CO2 removal: a task as challenging as for ECMO therapy

Hilty, Matthias P ; Riva, Thomas ; Cottini, Silvia R ; Kleinert, Eva-Maria ; Maggiorini, Alessandra ; Maggiorini, Marco

DOI: https://doi.org/10.23736/S0375-9393.18.12705-2

eases: evidence, indications, and exclusions. In: Schmidt GA, editor. Extracorporeal life support for adults. New York: Springer Science+Business Media; 2016. p. 87-103.
3. Amato MBP, Meade MO, Slutsky AS, Brochard L, Costa EL, Schoenfeld DA, *et al.* Driving pressure and survival in the acute respiratory distress syndrome. N Engl J Med 2015;372:747-55.
4. Morelli A, Del Sorbo L, Pesenti A, Ranieri VM, Fan E. Extracorporeal carbon dioxide removal ($ECCO_2R$) in patients with acute respiratory failure. Intensive Care Med 2017;43:519-30.

Conflicts of interest.—The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Article first published online: November 17, 2017. - Manuscript accepted: November 14, 2017. - Manuscript received: September 19, 2017.

(*Cite this article as:* Pettenuzzo T, Del Sorbo L. Right patient selection and management in veno-venous extracorporeal carbon dioxide removal. Minerva Anestesiol 2018;84:409-10. DOI: 10.23736/S0375-9393.17.12437-5)

Online version at http://www.minervamedica.it
Minerva Anestesiologica 2018 March;84(3):410-1
DOI: 10.23736/S0375-9393.18.12705-2

Patient selection for extracorporeal CO_2 removal: a task as challenging as for ECMO therapy

Dear Editor,

We would like to thank Pettenuzzo and Del Sorbo for their insightful comment [1] on our article exploring the feasibility of low flow veno-venous extracorporeal CO_2 removal ($ECCO_2R$) in acute hypercapnic respiratory failure.[2]

The patient population included in our study reflects the typical case mix present in a universitary intensive care unit affiliated with a lung transplantation unit. Despite the resulting population heterogeneity, this approach was chosen in order to enable a feasibility assessment of $ECCO_2R$ that is closely rooted in reality, as well as verification in a broad population of our preliminary indications for therapy that were, based on previous literature, focused on parameters regarding respiratory failure.[3] We were thus able to identify a subpopulation where further risk stratification is necessary to avoid treatment futility, namely mechanically ventilated patients mainly suffering from acute respiratory distress syndrome (ARDS). Based on these results, as is stated in our article, we agree with Pettenuzzo and Del Sorbo that the indications for $ECCO_2R$ need to be refined – especially in patients whose outcome depend on successful bridging to recovery. The PRESERVE score as a tool for assessment of recovery potential in ARDS patients where veno-venous extracorporeal membrane oxygenation (ECMO) therapy is considered,[4] has recently been validated in our population of ARDS patients treated with ECMO.[5] Preliminary results from our ongoing research suggest that the PRESERVE score may further be a useful tool for selection of patients suffering from hypercapnic respiratory failure in ARDS for treatment with $ECCO_2R$, representing a more sensible approach than the use of isolated criteria. Our protocol, in an attempt to position the use of $ECCO_2R$ as a rescue therapy, further favored the inclusion of patients at the limit of lung protective mechanical ventilation, resulting in a median peak inspiratory pressure of 31 mbar and tidal volume of 5.2 mL/kg, corresponding to the original ARDS network guidelines. As a consequence of low overall lung compliance the resulting median driving pressure was 25 mbar before initiation of $ECCO_2R$. Given the most recent results including the study by Amato *et al.* and referenced by Pettenuzzo and Del Sorbo,[6] that were published since the conclusion of our study, we agree that driving pressure (ΔP=Pplat-PEEP) should be considered in the inclusion criteria for $ECCO_2R$ in mechanically ventilated patients in the future. We suggest considering $ECCO_2R$ treatment in patients suffering from hypercapnic respiratory failure with pH≤7.25 and/or $PaCO_2$≥9 kPa, where in mechanically ventilated patients an inability is reached to maintain VT≤6 mL/kg, Pplat≤30 mbar and ΔP≤15 mbar, and to base this expert decision on similar criteria as applied in considering ECMO therapy, possibly including the PRESERVE score in ARDS patients in order to avoid futile treatment.

In awake spontaneously breathing patients, mortality in our population was low but an eventual upgrade from $ECCO_2R$ to full ECMO was necessary in a majority of patients. This is unsurprising considering that more patients in the respective group suffered from cystic fibrosis awaiting lung transplantation than other indications such as exacerbated chronic obstructive pulmonary disease. Arguably, in these patients ECMO duration was reduced by up to 4.3 days. If using $ECCO_2R$ to delay more invasive ECMO treatment results in a benefit for patients remains to be examined in future studies. Due to the low number of patients, our study does not allow to draw conclusions regarding success of bridge to recovery in awake spontaneously breathing patients such as patients with exacerbated chronic obstructive pulmonary disease.

As Pettenuzzo and Del Sorbo point out, spontaneous breathing increases variability in airway and intrathoracic pressure. Even though NIV has the capac-

ity to add between 5 and 15 mbar of positive airway pressure, this would not be sufficient to counteract negative pleural pressure induced by forced inspiratory maneuvers in spontaneous breathing during respiratory failure. We thus believe that the most likely explanation for our observation that target flow rates were more difficult to achieve in these patients is the association with negative inspiratory pressure during inspiration, while of course another factor is increased mobility in awake patients. We are not aware of previous studies reporting pleural pressure measurements during awake ECMO or $ECCO_2R$ treatment. However, our subjective experience with $ECCO_2R$ is similar to veno-venous ECMO treatment in awake versus in mechanically ventilated patients, supporting this hypothesis. Apart from blood flow rate, efficiency of the gas exchange membrane further determines system efficiency. $PvCO_2$, as determined in Table III in our article [2] as the sum of post membrane PCO_2 and pre to post membrane ΔPCO_2 neither changed over the course of membrane system lifetime, nor between one and 48 hours of $ECCO_2R$ treatment ($P>0.05$). The influence of membrane efficiency, $PvCO_2$ and blood flow rate on post membrane PCO_2 is complex,[7] thus real-life data is needed to discern its value in a clinical setting. By demonstrating consistency in $PvCO_2$ during the later stages of treatment, our data suggests that post membrane CO_2 dependence on $PvCO_2$ becomes less relevant and thus is a good surrogate measurement of membrane efficiency during that period of treatment. Technological development has since enabled measurement of CO_2 concentration within the membrane sweep gas outlet, further eliminating inaccuracies introduced by difficulties in assessing total CO_2 content in blood samples, which will be reflected in future studies.

Matthias P. HILTY [1] *, Thomas RIVA [1], Silvia R. COTTINI [2], Eva-Maria KLEINERT [1], Alessandra MAGGIORINI [1], Marco MAGGIORINI [1]

[1]Unit of Medical Intensive Care, University Hospital of Zurich, Zurich, Switzerland; [2]Unit of Surgical Intensive Care, University Hospital of Zurich, Zurich, Switzerland

*Corresponding author: Matthias P. Hilty, Unit of Medical Intensive Care, University Hospital of Zurich, Rämistrasse 100, 8091 Zurich, Switzerland. E-mail: matthias.hilty@usz.ch

References

1. Pettenuzzo T, Del Sorbo L. Right patient selection and management in veno-venous extracorporeal carbon dioxide removal. Minerva Anestesiol 2018;84:409-10.
2. Hilty MP, Riva T, Cottini SR, Kleinert EM, Maggiorini A, Maggiorini M. Low flow veno-venous extracorporeal CO2 removal for acute hypercapnic respiratory failure. Minerva Anestesiol 2017;83:812-23.
3. Terragni PP, Del Sorbo L, Mascia L, Urbino R, Martin EL, Birocco A, *et al.* Tidal volume lower than 6 ml/kg enhances lung protection: role of extracorporeal carbon dioxide removal. Anesthesiology 2009;111:826-35.
4. Schmidt M, Zogheib E, Rozé H, Repesse X, Lebreton G, Luyt CE, *et al.* The PRESERVE mortality risk score and analysis of long-term outcomes after extracorporeal membrane oxygenation for severe acute respiratory distress syndrome. Intensive Care Med 2013;39:1704-13.
5. Klinzing S, Wenger U, Steiger P, Starck CT, Wilhelm M, Schuepbach RA, *et al.* External validation of scores proposed for estimation of survival probability of patients with severe adult respiratory distress syndrome undergoing extracorporeal membrane oxygenation therapy: a retrospective study. Crit Care Lond Engl 2015;19:142.
6. Amato MBP, Meade MO, Slutsky AS, Brochard L, Costa ELV, Schoenfeld DA, *et al.* Driving pressure and survival in the acute respiratory distress syndrome. N Engl J Med 2015;372:747-55.
7. Karagiannidis C, Strassmann S, Brodie D, Ritter P, Larsson A, Borchardt R, *et al.* Impact of membrane lung surface area and blood flow on extracorporeal CO2 removal during severe respiratory acidosis. Intensive Care Med Exp 2017;5:34.

Conflicts of interest.—The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Article first published online: February 5, 2018. - Manuscript accepted: February 2, 2018. - Manuscript received: January 8, 2018.

(*Cite this article as:* Hilty MP, Riva T, Cottini SR, Kleinert EM, Maggiorini A, Maggiorini M. Patient selection for extracorporeal CO_2 removal: a task as challenging as for ECMO therapy. Minerva Anestesiol 2018;84:410-1. DOI: 10.23736/S0375-9393.18.12705-2)

Online version at http://www.minervamedica.it
Minerva Anestesiologica 2018 March;84(3):411-3
DOI: 10.23736/S0375-9393.17.12083-3

The search for perfect supraglottic airway device: *but I still haven't found what I am looking for*

Dear Editor,

We read with interest the article by Kriege *et al.*[1] and we would like to point out some comments regarding expectations and performances of supraglottic airway devices (SADs).

The rigorous method adopted by Kriege [1] for both data collection and analysis is clear proof of the ongo-